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TECHNICAL SPECIFICATION FOR SPUN CONCRETE POLES

1) SCOPE :

This specification covers design manufacture testing and supply of pre stressed concrete circular spun poles/designed for a working load of 500 Kgs.

2) Applicable Standards :

The poles shall comply with the relevant provisions made in the following Indian Standards Specifications or the latest versions thereof, except when they conflict with the specific requirements in this specific requirement in this specification.

a. IS 1678-1978 – Specification for the stressed concrete poles for overhead power, traction and telecommunication lines.

b. IS 2905-1966 – Methods of test for concrete poles for overhead power and telecommunication lines.

c. IS 7321-1974 – Code of practice for selection, handling and erection of concrete poles for overhead power and telecommunication lines.

d. IS **13158**-1991 – Pre stressed concrete circular spun poles for overhead power.

Materials meeting any other authoritative standards which ensure an equal or better quality than the standards mentioned above will also be acceptable. In such cases, English version of the standard adopted should be enclosed to the offer.

3) Terminology:

For the purpose of this specification, the definitions of Average Permanent Load, Load Factor and Transverse Load at first crack, Ultimate Failure, Ultimate Transverse Load and Working Load shall be as per IS 1678 or any other equivalent International Standards.

4) Dimensions and Shape:

The poles shall be of hollow circular section with an outside taper of 1:65. The diameter and thickness shall be as per design requirements. The tolerances shall be as follows:

Outer diameter	+4,	(-) 2mm
Length	+50,	(-) 10mm

5) Cement:

5.1. High strength ordinary Portland cement conforming to IS:8112 or ordinary Portland Cement conforming to IS: 269-1976 or rapid hardening cement conforming to IS-804 1 E-1978 or any other equivalent International Standards shall be used, which shall have the following additional requirements:

5.2

a) Initial Setting Time : Not less than 30 minutes.

b) Final Setting Time : Not more than 600 minutes.

The minimum compressive strength of standard mortar cube with standard sand as per IS:650 at 7 days shall be 375 Kgs/cm square.
A minimum of 3 trial cubes shall be made with aggregate grading to be used for the approved design mix and the average compressive strength results at 7 days, shall be determined to assess the suitability of the cement for every batch of cement.

6) Aggregates:

Coarse and fine aggregates used for the casting of poles shall conform to IS:383 or any other equivalent international Standards. The nominal max size of aggregates shall in no case exceed 20 mm or 1/4th the minimum thickness of the pole, whichever is less., provided further that the size of aggregates shall be at least 5mm less than the spacing between the pre-stressing wires.

Each size of graded aggregate shall be stocked in different storage bins or stock piles and shall be mixed only after the quantity required for each size has been separately weighed. The storage bins or stock piles shall be under cover to protect from weather.

7) Water:

Water should be free from chlorides, sulphates, other salts and organic matter Potable water will be generally suitable.

8) Admixtures:

Admixtures should not contain calcium chloride or other chlorides and salts which are likely to promote corrosion of pre-stressing steel.

9) Reinforcement:

9.1 Reinforcing bars and wires used for the manufacture of prestressed concrete poles shall conform to the following Indian Standards or any other equivalent International Standards.

a. IS:1785(Part-I) Specification for plain hard drawn steel wire for prestressed concrete: Part-I cold-drawn stress relieved wire (second revision).

b. IS:1785(Part-II) – 1983 Specification for plain hard drawn steel wire for pre stressed concrete: Part-II as drawn wire (First revision).

c. IS:2090-1983 – Specification for high tensile steel bars used in pre stressed concrete (first revision).

d. IS:6003-1983 Specification for indented wire for prestressed concrete (first revision)

e. IS:6006-1983 specification for uncoated stress relieved strand pre stressed concrete (first revision).

9.2 The surface of all reinforcement shall be free from loose scale, oil, grease, clay or other material that may have deteriorating effect on the bond between the reinforcement and the concrete.

10) Concrete:

The concrete mix shall be designed to the requirement laid down for controlled concrete (also called design mix concrete) in IS-1343 (code of practice for pre stressed concrete) and 1S-456 (code of practice for plain and reinforced concrete) or any other equivalent International standards subject to the following special conditions.

a. Minimum works cube strength at 28 days should bc at least 50N/mm square.
b. The concrete strength at transfer should be at least half the 28 days strength ensured in the design.

11) Design Requirements:

The pole shall be designed for the following requirements:

a. Factor of safety for the poles shall not be less than 2.0
b. The average permanent load shall be taken as 50% of the working load.

c. The F.O.S. against first crack load shall be 1.0

d. At average permanent load, permissible tensile stress in concrete shall be 3.0 N/mm square.

e. At the design value of first crack load, the hypothetical flexural tensile stress of M 50 concrete grade shall not exceed 6.3 N/mm square.

f. The maximum compressive stress in concrete at the time of transfer of pre stress shall not exceed 0.8 times the cube strength.

12) Moulds:

Moulds shall be of steel and or rigid construction to prevent distortion and so arranged as to provide smooth surfaces. The moulds shall not allow any leakagc of cement grout during casting. The holes in the end plates for the HT wires shall be accurately drilled by jigs to ensure inter-changeability. The end plates shall be designed to withstand the forces arising out of the change in direction of pre-stressing wires during tensioning.

13) Tensioning of Wires:

13.1 The HT wires shall be placed axially at regular spacing along the circumference. The spacing shall bc as pcr IS 1678 or any othcr equivalent to International Standards. While cutting in of HT wires will be by automatic machines, button heading and forming reinforcement cages shall be done manually.
13.2 Helical steel shall be 2.7mm dia MS wires and the pitch shall be 150mm.
13.3 The clear cover shall be 20mm
13.4 Pre-stressing shall be by automatic machincs. Forcc shall bc applied on thc entire group of HT wires to ensure all wires are equally stressed.
13.5 The pre-stressing wires shall be stretched by an approved method. The anchoring of the stretched wires shall be such that during manufacture and

until the wires are released, no slipping occurs. The force at the time of initial stretching shall in addition to imparting of designed prestress also be sufficient to overcome the friction on account of any change in the inclination of wires and slippage that might occur during the anchoring process which will have to be suitably compensated.

13.6 The tensioning of pre-stressing steel shall be carried out in a manner that will induce a smooth and even rate of increase of stress in the wires.

13.7 The force induced in the pre-stressing wires shall be determined by means of gauges attached to the tensioning apparatus and cross checked by extension to be achieved shall be determined in advance, based on trials conducted on representative samples of the wires as used in the poles. The accuracy of the devices for measuring of the tensioning force shall be within plus or minus 5%.

14) Mixing and Consolidation of Concrete.

14.1 Provision shall be made to measure the quantities of cement and of fine and coarse aggregates by weight only. The accuracy of the measuring equipment shall be plus or minus 3%. All the measuring equipments shall be maintained in clean, serviceable condition and its accuracy checked regularly. Modern high speed mixers, preferably pan or turbine type shall be used for mixing the concrete.

14.2 The manufacture of poles shall be done under suitable cover and not in the open.

14.3 The concrete shall be thoroughly mixed and consolidated.

14.4 The freshly cast poles shall be protected during the first stage of hardening form the harmful effects of sunshine, dry winds, cold and rains.

15) Detensioning of Wires:

15.1 The anchoring system shall provide a device for gradual detensioning of the wires. No back pulling of the wires shall be permitted in the gradual detensioning device for the purpose of release of any wedge or other parts of the detensioning device. Flame cutting of the wires before release of the full tension shall be strictly prohibited.

15.2 The transfer of prestress shall not be effected until the concrete in the poles has attained the specified as established of cube tests.

Curing:

16.1 The curing shall be done on a saturated steam at 65 degree centigrade to ensure that 80% ultimate strength is reached in 6 hours. Thereafter the HT wires will be cut, poles demoulded and transferred to water for 14 days curing.

16.2 During manufacture, periodical tests on concrete cubes of preferably spun hollow cylindrical specimen measuring 200mm in dia and 300mm in height shall be carried out till the concrete achieves the required strength at transfer. Thereafter the test on concrete shall be carried out as detailed in IS:1343 or any other equivalent international standards. The manufacturer shall supply when required by the purchaser results of compressive test conducted in accordance with IS:456 or any other equivalent International Standards on concrete cubes made from the concrete used for the poles. If the purchaser so desires the manufacturer shall supply cubes for test purpose and such cubes shall be tested in accordance with IS:456 or nay other equivalent International Standards.

17) Earthing:

17.1 Earthing shall be provided by having a length of 8SWG GI wire embedded in concrete during manufacture and ends of the wires left projecting from the pole to a length of 100 mm at 250 mm top and 150 mm below ground level.

17.2 Earth wire shall not be allowed to come in contact with the prestressing wires.

18) Finish:

18.1 Poles shall be free from surface defects including hair cracks. The surface of the poles in contact with the steel mould shall be smooth and regular in shape and shall as far as possible, be free from pores. Water retaining pockets or honey-combing formation shall not be admissible. 25mm thick 1:2 cement mortar cover shall be provided on the full area of the top of pole.

18.2 The ends of the prestressing wire shall be cut as close to the surface of the pole as possible and in any case shall not project more than 3mm.

18.3 The ends of the prestressing wire shall be given two coats of suitable anti-coorrosive paints approved by the purchaser.

18.4 No touching up or finishing by cement grout, etc., shall be done on the poles after it is removed from the moulds.

18.5 A metallic base plate shall be provided at the bottom of pole.

19) Welding and Lapping of Steel:

The high tensile steel wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case. However, joining or coupling may be permitted provided the strength of the joint of coupling is not less than the strength of each individual wire.

20) Provision of Holes & Hooks:

20.1 Through holes shall be provided for fixing cross arms and top clamp as specified by purchaser.

20.2 PVC inserts shall be provided at intervals of 600mm on alternate sides for fixing up of step bolts along the length of pole.

20.3 A set of step up bolts shall be supplied along with each lot of 100 poles.

21) Tests:

21.1 During manufacture, tests on concrete shall be carried out as detailed in clause 16.2 of this specification.

21.2 Transverse strength test.

21.2.1 Poles made of ordinary Portland cement shall be tested on the completion of 28 days and poles made from rapid hardening cement only on the completion of 14 days after the day of manufacture.

21.2.2 The pole may be tested in either horizontal or vertical position. If tested in horizontal position, provision shall be made to compensate for the overhanging weight of the pole. For this purpose, the overhanging portion of the pole may be supported on a movable trolley or similar device.

21.2.3 The pole shall be rigidly supported at the butt end for a distance equal to the agreed depth of planting i.e. 1.8 mtr.

21.2.4 Load shall be applied at a point 600mm from the top of the pole and shall be steadily and gradually increased to the design value of the transverse load at first crack. The deflection at this load shall be measured.

21.2.5 A pre-stressed concrete pole shall be deemed not to have passed the test if visible cracks appear at a stage prior to the application of the desigr transverse load for the first crack.

21.2.6 The load shall then be reduced to zero and increased gradually to a load equal to the first crack load plus 10% of the minimum ultimate transverse load and held up for 2 minutes. This procedure shall be repeated until the load reaches the value of 80% of the minimum ultimate transverse load and thereafter increased by 5% of the minimum ultimate transverse load until failure occurs. Each time the load is applied, it shall be held for 2 minutes. The load applied to pre-stressed concrete pole at the point of failure and shall be measured to the nearest five kilograms.

21.2.7 The pole shall be deemed not to have passed the test if the observed ultimate transverse load is less than the designed ultimate transverse load.

22) Sampling and Testing:

22.1 scale of sampling:

22.1.1 Lot-In a consignment, 500 poles or part there of the same mounting height, same dimensions and belonging to the same batch of manufacture, shall be grouped together to constitute a lot.

22.1.1.1 Sub-Lot: If the number of poles in a lot exceeds 500, the lot shall be divided into a suitable number of sub-lots such that the number of poles if any, sub-lot shall not exceed 500. The acceptance or otherwise of a sub lot shall be determined on the basis of the performance of samples selected from it.

22.1.2 The number of poles to be selected from a lot or a sub lot shall depend upon its size and shall be in accordance with col. 1 and 2 of the following table:

Size of lot	Dimensional Requirement		
	Sample Size	Permissible No. of Defective Samples	No. of poles for transverse strength test
(1)	(2)	(3)	(4)
Upto 100	10	1	(*)
101 to 200	15	1	3
201 to 300	20	2	4
301 to 500	30	3	5

(*) The No. of Poles to be tested shall be subject to confirmation by inspecting staff.

22.1.3 These poles shall be selected at random, in order to ensure randomness, all the poles in the lot or the sub-lot may be arranged in a serial order and starting from any random pole, every 'r'th pole may be included in the sample, 'r' being the integral part of N/n where N is the size of the lot or the sub-lot and 'n' is the sample size.

22.2 Number of Tests:

22.2.1 All the poles as selected in 22.1.2 shall be tested for overall length, cross-section and uprightness. The permissible tolerances shall be +/- 15 mm on over all length, +/- 3mm on cross sectional dimensions and 0.5% on uprightness.

22.2.2 The number of poles to be tested for transverse strength test shall be in accordance with col. 4 of the table in 22.1.2. These poles may be selected from those already tested in 22.2.1.

22.3 Criteria for Conformity:

22.3.1 A lot or sub-lot shall be considered as conforming to this specification if the conditions under 22.3.2 and 22.3.3 are satisfied.

22.3.2 The number of poles which do not satisfy the requirements of overall length, cross-section and uprightness shall not exceed the corresponding number given in col.3 of the Table under clause 22.1.02. If the number of such poles exceeds the corresponding number, all poles in the lot or sub-lot shall be tested for these requirements., and those not satisfying the requirements shall be rejected.

22.3.3 All the poles tested for transverse strength test shall satisfy the requirements of the test, if one or more poles fail, twice the number of poles originally tested, shall be selected form those already selected and subjected to the test. If there is no failure among these poles, the lot or the sub-lot shall be considered to have satisfied requirements of this test.

23) Marking:

The poles shall be clearly engraved and indelibly marked with the following particulars either during or after manufacture but before testing at a position so as to easily read after erection in position:

a. Month and year of manufacture.
b. Transverse strength of pole in kg.
c. Serial number of the pole.
d. Position of center of Gravity of the pole with the word C.G.
e. Line indicating depth of planting.
f. BESCOM

General Manager, Ele.,
Procurement, BESCOM.

TECHNICAL SPECIFICATIONS FOR 8 Mtr & 9 Mtr PSCC POLES OF WORKING LOAD 200 KGS (EQUIVALENT TO RCC POLES)

1.0 SCOPE:

1.1 This Specification covers the manufacture as per designs, testing and supply of 8 Mtr and 9 Mtr Long Pre stressed Cement Concrete Poles (PSCC) - 200 Kg Working Load.

The poles shall be manufactured according to REC Standard with Working Load of 200 Kg. (designed, tested, and approved by the Cement Research Institute of India) the details of which are furnished in the drawings enclosed.

2.0 APPLICABLE STANDARDS

2.1 Except when they conflict with specific requirement in this specification, the poles shall comply with the relevant provisions made in the latest version of the following Indian Standards specifications:

a) IS:1678/1998 Specification for pre stressed concrete poles for overhead power, traction and telecommunication lines.

b) IS:2905/1989 Methods of tests for concrete poles for overhead power and telecommunication lines.

c) IS:7321/1974 Code of practice for selection, handling and erection of concrete poles for overhead power and telecommunication lines.

3.0 MATERIALS

3.1 **Cement:** The cement used in the manufacture of pre-stressed concrete poles shall be any one of the following 53 Grade ordinary Portland cement conforming to IS:12269.

a) Portland slag cement conforming to IS:455 but with not more than 50 percent slag content.

b) Rapid hardening Portland cement conforming to IS:8041.

c) 43 Grade ordinary Portland cement conforming to IS:8112, and

d) 53 Grade ordinary Portland cement conforming to IS:12269.

3.2 **Aggregates:** Aggregates used for manufacture of pre-stressed concrete poles shall conform to IS:383 (Specification for coarse and fine

aggregates from natural sources for concrete). The nominal maximum size of aggregates shall in no case exceed 12 mm.

3.3 **Water:** Water shall be free from chlorides, Sulphate, other salts and organic matter. Potable water will be generally suitable.

3.4 **Admixtures:** Admixtures should not contain chlorides in any form are likely to promote corrosion of pre-stressing steel. Admixtures shall conform to IS:9103 (Specification for admixtures for concrete).

3.5 **Pre stressing steel:** The pre stressing steel wires, including those used as un tensioned wires, should conform to any one of the following:

1. IS:1785 (Part-I) Specification for plain hard-drawn steel wire for pre-stressed concrete. Part-I-Cold drawn stress relieved wire,
2. IS:1785 (Part-II) Specification for plain hard drawn steel wire for pre-stressed concrete, Part-II. As drawn wire, or
3. IS 6003 Specification for indented wire for pre-stressed concrete,
4. Uncoated stress relieved strand conforming to IS:6006 or IS:14268
5. High tensile steel bar conforming to IS:2090

The type designs given are for plain wires of 4 mm dia with guaranteed ultimate strength of 175 Kg/mm^2. All pre stressing steel shall be free from splits, harmful stretches, surface flaws, rough, aged and imperfect edges and other defects likely to impair its use in Pre stressed concrete.

4.0 CONCRETE MIX:

4.1 The concrete mix shall be designed to the requirement laid down for controlled concrete (also called design mix concrete) in IS:1343 Code of practice for pre stressed concrete and IS:456 Code of practice for plain and reinforced concrete, Subject to the following special conditions:

a) Minimum works cube strength at 28 days should be at least 420 Kg/Cm^2.

b) The Concrete strength at transfer should be atleast 210 Kg/Cm^2.

c) The mix should contain atleast **400 Kgs**. of cement per cubic meter of concrete.

d) The mix should contain low water content as is consistent with

adequate workability. If it becomes necessary to add water to increase the workability the cement content also should be raised in such a way that the original value of water cement ratio is maintained.

5.0 DESIGN REQUIREMENTS:

5.1 The poles shall be designed for the following requirements:

a) The poles shall be planted directly in the ground with a planting depth as indicated in drawing i.e., 1.5 Mtr for 8 Mtr poles and 1.7 Mtr for 9 Mtr poles.

b) The poles should be suitable to take up a load of 200 Kg applied at 0.6 Mtr from top.

c) The factor of safety for all these poles shall not be less than 2.5.

d) The average permanent load shall be 40% of the working load.

e) The FOS against first crack load shall be 1.0.

f) In the design value of first crack load the modulus of rupture shall not exceed 55.2 Kg/Cm^2 for M-40 concrete.

g) At average permanent load, permissible tensile stress in concrete shall be 30 Kg/Cm^2.

h) The ultimate moment capacity in the longitudinal direction should be at least one fourth of that in the transverse direction.

i) The maximum compressive stress in concrete at the time of transfer of pre stress should not exceed 0.8 times the cube strength.

j) The concrete strength at transfer shall not be less than half the 28 days strength ensured in the design, i.e., 420x0.5 = 210 Kg/Cm^2.

k) The Poles shall be manufactured as per the enclosed drawings.

6.0 DIMENSIONS AND REINFORCEMENTS:

6.1 The cross sectional dimensions and the details of pre-stressing wire should conform to the particulars as per drawings.

6.2 The provisions of holes for fixing cross arms and other fixtures should conform to the construction practice adopted by BESCOM.

7.0 MANUFACTURE:

7.1 All pre-stressing wires and reinforcements shall be accurately fixed as shown in the drawings and maintained in position during manufacture. The un tensioned reinforcement, as indicated in the drawings, should be held in position by the use of stirrups, which should go round all the wires.

7.2 All wires shall be accurately stretched with uniform pre-stress in each wire. Each wire or group of wires shall be anchored positively during casting. Care shall be taken to see that the anchorage does not yield before the concrete attains the necessary strength.

7.3 Cover: The cover of concrete measured from the outside of the pre-stressing tendon shall be normally 20 mm.

7.4 Welding & lapping of steel: The high tensile steel wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case. However, jointing or coupling may be permitted provided the strength of the joint or coupling is not less than the strength of each individual wire.

7.5 **Compacting:** Concrete shall be compacted by spinning, vibrating shocking or other suitable mechanical means. Hand compaction shall not be permitted.

7.6 **Curing:** The concrete shall be covered with a layer of sacking, canvas, hessian or similar absorbent material and kept constantly wet up to the time when the strength of concrete is at least equal to the minimum strength of concrete at transfer of pre-stress. Thereafter, the pole may be removed from the mould and watered at intervals to prevent surface cracking of the unit, the interval should depend on the atmospheric humidity and temperature.

7.7 The pre stressing wires shall be de tensioned only after the concrete has attained the specified strength at transfer (i.e., 210 Kg/Cm^2). The cubes cast for the purpose of determining the strength at transfer should be cured, as far as possible under conditions similar to those under which the poles are cured. The transfer stage shall be determined based on the daily tests carried out on concrete cubes till the specified strength

indicated above is reached. Thereafter the test on concrete shall be carried out as detailed in IS:1343 Code of practice for pre stressed concrete. The manufacturer shall supply when required by the Engineer or his representative, results of compressive test conducted in accordance with IS:456 Code of practice for plain and reinforced concrete on concrete cubes made from the concrete used for the poles. If the Engineer so desires, the manufacturer shall supply cubes for test purposes and such cubes shall be tested in accordance with IS:456 Code of practice for plain and reinforced concrete. The de-tensioning shall be done by slowly releasing the wires, without imparting shock or sudden load to the poles. The rate of de tensioning may be controlled by any suitable means either mechanical (Screw type) or hydraulic. The poles shall not be de tensioned or released by cutting the pre-stressing wires using flames or bar croppers while the wires are still under tension.

7.8 Stacking should be done in such a manner that the broad side of the pole is vertical. Each tier in the stack should be supported on timber sleepers located at 0.15 times the overall length, measured from the end. The timber supports in the stack should be aligned in a vertical line.

7.9 Poles should be transported with their broad faces placed vertically and in such a manner that shocks are avoided. The supports should be so arranged that they are located approximately at a distance equal to 0.15 times the overall length, from the ends. The erection of the pole should be carried out in such a way that the erection loads are applied so as to cause moment with respect to the major axis, i.e., the rope used for hoisting the pole should be parallel to the broader face of the pole.

8.0 EARTHING:

8.1 Earthing shall be provided by having a separate length of 4 mm dia GI Wire embedded in concrete during manufacture and the ends of wire left projecting from the burrow end of the pole to a length of 100 mm at 215 mm from top of the pole and 150 mm below ground level. The arrangement for termination of the earth wire and fixing of the bolt and

nut shall be as indicated in the enclosed drawings. The Wire used for embedding shall comply with the requirement of IS:2141/2000.

9.0 TESTS:

9.1 Transverse Strength Tests: Poles made from ordinary Portland cement shall be tested only on the completion of 28 days and poles made from rapid hardening cement, only on the completion of 14 days, after the day of manufacture.

9.2 The pole may be tested in either horizontal or vertical position. If tested in horizontal position, provisions shall be made to compensate for the overhanging weight of the pole. For this purpose, the overhanging portion of the pole may be supported on a movable trolley or similar device.

9.3 The pole shall be rigidly supported at the butt end for a distance equal to the depth of planting i.e., 1.5 Mtr for 8 Mtr poles and 1.7 Mtr for 9 Mtr poles.

9.4 Load shall be applied to at a point 600 mm from the top of the pole and shall be steadily and gradually increased to the design value of the transverse load for the first crack.

9.5 A Pre stressed concrete pole shall be deemed not to have passed the test if visible cracks appear at a stage prior to the application of the design transverse load for the first crack.

9.6 The load shall then be reduced to a zero and increased gradually to a load equal to the first crack load plus 10% of the minimum ultimate transverse load, and held up for 2 minutes. This procedure shall be repeated until the load reaches a value of 80% of the minimum ultimate transverse load and thereafter increased by 5% of the minimum ultimate transverse load until failure occurs. Each time the load is applied, it shall be held for 2 minutes. The load applied to Pre stressed concrete pole at the point of failure shall be measured to the nearest five kilograms.

9.7 The pole shall be deemed not to have passed the test if the observed ultimate transverse load is less than the design ultimate transverse

load.

9.8 **Destruction Test:** One pole out of a lot of 500 or less shall be subjected to destruction test to verify the steel and other aggregates used. No payment shall be made for the poles which are subject to Destruction test.

10.0 MEASUREMENT OF COVER:

10.1 After completion of the transverse strength test, the sample pole shall be taken and checked for cover. The cover of the pole shall be measured at 3 points, one within 1.8 Mtr from the butt end of the pole, the second within 0.6 Mtr. From the top and the third at an intermediate point and the mean value compared with the specified value.

10.2 The mean value of the measured cover should not differ by more than ±1 mm. from the specified cover. The individual values should not differ by more than ±3 mm. from the specified value. If these requirements are not met, the workmanship with reference to aligning of the end plates and pre stressing wires and assembly of moulds should be improved and inspection at production stage tightened suitably.

11.0 SCALE OF SAMPLING:

11.1 **Lot:** In any batch, all poles of the same class and same dimensions shall be grouped together to constitute a lot.

11.2 **Sub-Lot:** If the number of poles in a lot exceeds 500, the lot shall be divided into a suitable number of sub lots such that the number of poles in any sub lot shall not exceed 500. The acceptance or otherwise of a sub-lot shall be determined on the basis of the performance of samples selected from it.

3.1 The number of poles to be selected from a lot or a sub lot shall depend upon its size and shall be in accordance with Col. 1 and 2 of the following table

No. of poles in the Lot	Sample Size	Dimensional Requirement Acceptance Number	Transverse Strength Test	Transverse Strength Ultimate
1	2	3	4	5
Up to 100	10	1	2	1
101 to 200	15	1	3	1
201 to 300	20	2	4	1
301 to 500	30	3	5	2

The poles shall be selected at random. In order to ensure randomness, all the poles in the lot of the sub lot may be arranged in a serial order and starting from any random pole, every 7th pole may be included in the sample `r' being the integral part of N/n where `N' is the size of the sub lot and `n' is the sample size.

4.0 NUMBER OF TESTS :

4.1 All the poles as selected in accordance with Clause 11.3 shall be tested for overall length, cross section and uprightness. The tolerance shall be ±15 mm. on overall length, ±3 mm. on cross sectional dimensions and 0.5 % on uprightness.

4.2 The number of poles to be tested for transverse strength test shall be in accordance with column 4 of the above Table. These poles may be selected from those already tested.

5.0 CRITERIA FOR CONFORMITY:

5.1 A lot or sub lot shall be considered as conforming to this specification if the conditions under 11.1 and 11.2 are satisfied.

5.2 The number of poles, which do not satisfy the requirements of overall length, cross section and uprightness, shall not exceed the corresponding number given in column 3 of Table. If the number of such poles exceeds the corresponding number, all poles in the lot or Sub lot shall be tested for these requirements, and those not satisfying the requirements shall be rejected.

5.3 All the poles tested for transverse strength test shall satisfy the requirements of the test. If one or more poles fail, twice the number of poles originally tested shall be selected from those already selected and subjected to the test. If there is no failure among these poles, the lot or

the sub lot shall be considered to have satisfied the requirements of this test.

NOTE: No payment will be made for the tested pole, which fail or poles, which are tested, to destruction.

6.0 MARKING:

6.1 The pole shall be clearly engraved and indelibly marked with the following particulars during manufacture but before testing at a position so as to be easily read after erection in position.

a. Month and year of manufacture
b. Transverse strength of pole in Kg
c. Makers Sl.No. and mark
d. Line indicating depth of planting at 1.5 Mtr.
e. Engraved letters indicating "BESCOM".
f. P.O. No/Date
g. Any other details as specified.

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TECHNICAL SPECIFICATION FOR 11 KV COMPOSITE PIN INSULATORS

1.0 SCOPE :

This specification covers the design, manufacture, testing and supply of 11KV Composite Insulators. The composite insulators shall be pin insulators for straight line locations.

2.0 SYSTEM PARTICULARS:

- Nominal System Voltage 11 kV
- Corresponding highest system Voltage 12 kV
- Frequency 50 Hz with 3% tolerance
- Number of phase 3
- Neutral earthing: effectively grounded.

3.0 STANDARDS :

Unless otherwise specified elsewhere in the specifications insulators shall confirm to the latest revisions of all relevant standards available at the time of placement of the order. The standards are listed in Annexure 'A'.

4.0 GENERAL REQUIREMENTS

4.1 The composite insulators shall generally conform to latest Standards as listed in Annexure 'A'

4.2 The Composite Insulators will be used on lines on which the conductors will be ACSR of any size up to Coyote. The insulators should withstand the conductor tension, the reversible wind load as well as the high frequency vibrations due to wind.

4.3 Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc. and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC-60815/IS: 13134.

4.4 The size of Composite insulator, minimum creepage distance and mechanical strength along with hardware fittings shall be as follows:

Type of Composite insulator	Nominal System Voltage kV(rms)	Highest System Voltage kV(rms)	Visible discharge test voltage kV(rms)	Wet power frequency withstand voltage kV (rms)	Impulse withstand voltage kV(peak)	Minimum creepage distance in mm	Min. failing load kN
Pin Insulator	11	12	9	35	75	320	5

4.6 **Dimensional Tolerance of Composite Insulators**

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with-IEC 61109:

± (0.04d+1.5) mm when d≤300mm

± (0.025d+6) mm when d>300 mm.

Where, d being the dimensions in millimeters for diameter, length or creepage distance as the case may be. However no negative tolerance shall be applicable to creepage distance.

4.7 **Corona and RI Performance**

All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal parts shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operating conditions.

5.0 TECHNICAL DESCRIPTION OF COMPOSITE INSULATORS

Polymeric Insulators shall be designed to meet thc high quality, safety and reliability and should bc capable of withstanding a wide range of environmental conditions: Polymeric Insulators shall consist of THREE parts, at least two of which are insulating Parts:- (a) Core- the internal insulating part (b) Housing- thc external insulating part (c) Metal end fittings.

5.1 **CORE**

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be Boron free electrically corrosion resistant (ECR) glass fiber or Boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP rod shall be manufactured through Pultrusion process. The FRP rod shall be void free as proven through die penetration test. The FRP rod must pass electric leakage current test of 175V/mm. The leakage current shall not exceed 0.05mA.

5.2 **HOUSING:**

The FRP rod shall be covered by a seamless sheath of a silicone elastometric compound or silicone alloy or EVA compound of a thickness of 3mm minimum. It shall be one-piece housing using Injection Molding Principle to cxtrude directly onto the core and cover the core. Thc clastomer housing shall be designed to provide the

necessary creepage distance and protection against environmental influences. Housing shall conform to the requirements of IEC 61109/92-93 with latest amendments. The bonding of the elastomeric compound to the fibre glass rod shall be perfect and shall be proved by a peel off test as described elsewhere in this specification.

5.3 **WEATHERSHEDS**

The composite polymer weather sheds made of a silicone elastometric compound or silicone alloy or EVA compound shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections. It should protect the FRP rod against environmental influences, external pollution and humidity. The weather sheds should either be of EVA or have silicon content of minimum 30% by weight. The strength of the weather shed to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids. Housing and weathershed materials shall have tensile strength of 10MPa with 300% elongation minimum and tear strength of 20N/mm.

5.4 **METAL END FITTINGS (Pins):**

End fitting transmit the mechanical load to the core. They shall be made of spheroidal graphite cast iron, malleable cast iron or forged steel or aluminum alloy. They shall be connected to the rod by means of a controlled compression technique. Metal end fittings shall be hot dip galvanized after, all fittings have been completed. The material used in fittings shall be corrosion resistant. As the main duty of the end fittings is the transfer of mechanical loads to the core the fittings should be properly attached to the core by a coaxial or hexagonal compression process & should not damage the individual fibers or crack the core. The gap between fitting and sheath shall be sealed by a flexible EVA or silicone elastomeric compound or silicone alloy compound sealant. System of attachment of end fitting to the rod shall provide superior sealing performance between housing, i.e. seamless sheath and metal connection. The sealing must be moisture proof. The dimensions of end fittings of Insulators shall be in accordance with the standard dimensions stated in IEC: 60120/ IS: 2486 - Part-II /1989.

6.0 WORKMANSHIP

6.1 All the materials shall be of latest design and conform to the best engineering Practices adopted in the high voltage field. Bidders shall offer only such

insulators as are guaranteed by them to be satisfactory and suitable for continued good service in power transmission/distribution lines.

6.2 The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners.

6.3 The design of the insulators shall bc such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

6.4 The core shall be sound and free of cracks and voids that may adversely affect thc insulators.

6.5 Weather sheds shall bc uniform in quality. They shall be clean, sound, smooth and shall be free from defects and excessive flashing at parting lines.

6.6 End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress; effectiveness of sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth without projecting points or irregularities, which may cause corona. All load bearing surfaces shall be sooth and uniform so as to distribute the loading stresses uniformly.

6.7 All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/sq.m. or 87 micron thickncss and shall be in accordance with the requirement of IS:4759. the zinc used for galvanizing shall be of purity 99.5% as per IS:4699. The zinc coating shall be uniform, adherent, smooth, reasonably bright continuous and free from imperfections such as flux, ash rust stains, bulky white deposits and blisters. The galvanized metal parts shall be guarantccd to withstand at least four successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

7.0 TESTS AND STANDARDS

Insulators offered shall be manufactured with the samc configuration & raw materials as used in the insulators for which design & type test reports are submitted. The manufacturer shall submit a certificate for the same. **The design & type test reports submitted should have been carried out within five years prior** to the date of opening of this tender.

7.1 DESIGN TESTS:

For polymeric insulators it is essential to carry out design test as per clause 4.1 of IEC 61109/92-93 with latest amendments. The design tests are intended to verify

the suitability of the design, materials and method of manufacture (technology). When a composite insulator is submitted to the design tests, the result shall be considered valid for the whole class of insulators, which are represented by the one tested and having the following characteristics:

- Same materials for the core, and sheds and same manufacturing method;
- Same material of the fittings, the same design, the same method of attachment;
- Same or greater layer thickness of the shed material over the core (including a sheath where used);
- Same or smaller ratio of the highest system voltage to insulation length;
- Same or smaller ratio of all mechanical loads to the smallest core diameter between fittings
- Same or greater diameter of the core.

The tested composite insulators shall be identified by a drawing giving all the dimensions with the manufacturing tolcranccs.

Manufacturer should submit test reports for Design Tests as per IEC – 61109 (clause – 5) along with the bid. Additionally following tests shall be carried out or reports for the tests shall be submitted after award of contract:

UV test: the test shall be carried out in line with clause 7.2 of ANSI C29.13.

7.2 TYPE TESTS:

The type tests are intended to verify the main characteristics of a composite insulator. Thc typc tcsts shall bc applicd to compositc insulators, thc class of which has passed the design tests.

7.2.1 Following Type test shall be conducted on a suitable number of individual insulator units, components, materials :

SL. No	Description of type test	Test procedure/standard	
1	Dry lightning impulse withstand voltage test	As per IEC 61 109 (clause 6.1)	
2	Wet power frequency test	As per IEC 61 1 09 (clause 6.2)	
3	Mechanical load-time test	As per IEC 61 1 09 (clause 6.4)	
4	Radio interference test	As per IEC 61 109 (clause 6.5) revised	
5	Recovery of Hydrophobicity test	Annexure - B	This test may be repeated every 3yrs by the manufacturer
6	Chemical composition test for silicon content	Annexure - B	Or any other test method acceptable to the owner.
7	Brittle fracture resistance test	Annexure – B	

The bidder shall submit type test reports as per IEC 61109 along with the bid. Additional type tests required if any shall be carried out by the manufacturer, after award of contract for which no additional charges shall be payable. In case, the tests have already been carried out, the manufacturer shall submit reports for the same.

7.2.2 UV Resistance as per ASTMG 53: 5000 Hours- UV Light for 8 hours and condensation for 4 hours in a continuous cycle. Elongation to be limited to 20% (% of elongation to break before and after the test)

7.2.3 Salt Fog Test: On Insulator for 1000hours as per IEC.

7.3. Acceptance (sample) Tests

The test samples after having withstood the routine test shall be subject to the following acceptance tests in order indicated below:

(a)	Verification of dimensions	Clause 7.2 IEC: 61109,
(b)	Verification of the locking system: (if applicable)	Clause 7.3 IEC : 61109,
©	Galvanizing test	IS:2633/15: 6745
(d)	Verification of the specified mechanical load	Clause 7.4IEC: 61109,
(e)	Verification of tightness of the interface between end fitting & insulator housing	Clause 7.4IEC: 61109, amendment 1 of 1995

7.4 Routine Tests

Sl No	Description	Standard
1	Identification of marking	As per IEC: 61109
2	Visual Inspection	As per IEC:61109
3	Mechanical Routine test	As per IEC:61106

Every Polymeric Insulator shall withstand Mechanical Routine test at ambient temperature, Tensile Load at RTL corresponding to atleast 50% of the SML for atleast 10 seconds.

7.5 Tests during manufacture:

Following tests shall also be carried out on all components as applicable

a)	Chemical analysis of zinc used for galvanizing
b)	Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.
c)	Chemical analysis, hardness tests and magnetic particle inspection for forgings.
d)	Peel off test to confirm adhesion of EVA/ Silicon /Silicon alloy to the core of the insulator.

7.6 Tests on the material used in manufacture of the insulator:

The bidder shall furnish following test reports conducted on the raw materials (i.e., silicon rubber or EVA) for confirming following properties along with their bid.

Sl. No	Property	Standard
1	Tensile Strength (MPa)	ISO37/ASTM D 638
2	Elongation (%)	ISO37/ASTM D 638
3	Tear Strength (N/mm)	ASTM D624B

4	TERT (4.5KV 360min)	ASTM D2303/IEC507
5	Volume Resistivity (Ohm -cm)	ASTM D257/IEC93
6	Dielectric constant	IEC 250/ ASTM D150
7	Dielectric Strength (kV/mm)	ASTM D149/IEC93
8	Density	ISO 1183A
9	Hardness (shore A)	ISO868
10	Accelerated aging	ISO188/ ASTM G53
11	Flammability test	UL-94 V0/IEC60707
12	Arc Resistance	IEC61621

7.7 The following characteristics shall be met by FRP rods used in manufacture of the insulator:

1. Tensile strength: 760 N/mm² Min
2. Glass content (%) : 75% min
3. Tg by DSC – 110 Deg C min
4. Dye penetration – No dye rise on 10 sample of 10 mm thick> 15 mins
5. Water diffusion & Voltage tests – 100 hours – 12kv for 1 min, no puncture or flashover on the FRP & current shall not exceed 1 mA
6. Hardness> 51 Barcol No
7. ECR glass – Boron/alkali content not more than 0.8%.

7.8 Additional Tests

7.8.1 The Owner reserves the right at his own expenses, for carrying out any other test(s) of reasonable nature carried out at Supplier's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the Specifications.

7.8.2 The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Supplier's premises or at any other test center. In case of evidence of non compliance, it shall be binding on the part of the Supplier to prove the compliance of the items to the technical specifications by repeat tests or correction of deficiencies or replacement of defective items, all without any extra cost to the Owner.

7.9 Co-ordination for Testing

7.9.1 The bidder shall intimate the Owner about carrying out of the type tests along with detailed testing programme at least 3 weeks in advance of the scheduled date of testing during which the Owner will arrange to depute his representative to be present *at* the time of carrying out the tests.

8.0 QUALITY ASSURANCE PLAN :

8.1 The bidder shall submit following information along with the bid:

8.1.1 Test certificates of the raw materials and bought out accessories.

8.1.2 Statement giving list of important raw material, their grades along with names of Sub suppliers for raw materials, list of standards according to which the raw materials are tested. List of tests normally carried out on raw materials in the presence of bidder's representative.

8.1.3 List of manufacturing facilities available.

8.1.4 Level of automation achieved and lists of areas where manual processing exists.

8.1.5 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

8.1.6 List of testing equipments available with the bidder for final testing of equipment along with valid calibration reports.

8.1.7 The manufacturer shall submit Manufacturing Quality Assurance Plan (QAP) followed during manufacture and testing.

8.2 The successful bidder shall submit the routine test certificates of bought out raw materials/accessories and central excise passes for raw material at the time of inspection.

8.3 The Purchaser representative shall at all times be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Supplier's and sub-Supplier's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.

8.4 The material for final inspection shall be offered by the Supplier only under packed condition. The owner shall select samples at random from the packed lot for carrying out acceptance tests. The lot offered for inspection shall be homogeneous and shall contain insulators manufactured in 3-4 consecutive weeks.

8.5 The Supplier shall keep the Owner informed in advance of the time of starting and the progress of manufacture of material in their various stages so that arrangements could be made for inspection.

8.6 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the owner in writing waives off the inspection. In the later case also the material shall be dispatched only after satisfactory testing specified herein has been completed.

8.7 The acceptance of any quantity of material shall in no way relieve the Supplier of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective.

9.0 TEST CERTIFICATE :

The tenderer shall furnish detailed type test reports of the offered composite Insulators as per clause 8.2 of the Technical Specifications at the NABL approved laboratories to prove that the composite Insulators offered meet the requirements of the specification. These Type Tests should have been carried out within five years prior to the date of opening of this tender.

10.0 TESTING FACILITIES :

The tenderer must clearly indicate what testing facilities are available in the works of the manufacturer and whether facilities are adequate to carry out all Routine & acceptance Tests. These facilities should be available to Purchasers Engineers if deputed to carry out or witness the tests in the manufacturer works. If any test cannot be carried out at the manufacturer's work, the reasons should be clearly stated in the tender. The insulators shall be tested in accordance with the procedure detailed in IEC 61109 / 92-93 with latest amendments.

11.0. DRAWINGS :

The insulator shall be as per the Drawing enclosed.

12.0 RETEST AND REJECTION:

12.1 Sample Procedure for testing of insulators shall be as per clause 7.1 to 7.6 of IEC 61109 for Acceptance & Routine Tests. For the sampling tests, two samples are used, E1and E2. The sizes of these samples are indicated in the table below.

Lot Size(N)	Sample size	
	E1	E2
N<300	Subject to agreement	
300<N<2000	4	3
2000<N<5000	8	4
5000<N<10000	12	6

If more than 10000 insulators are concerned, they shall be divided into an optimum number of lots comprising between 2000 and 10000 insulators. The results of the tests shall be evaluated separately for each lot. The insulators shall be selected by the purchaser's representative from the lot at random. The samples shall be subjected to the applicable sampling tests.

The sampling tests are:

Verification of dimensions - (E1 + E2)
Verification of the locking system - (E2)
Verification of tightness of the interface between end fittings & Insulator housing - (E2)

Verification of the specified mechanical load SML - (E1)
Galvanizing test - (E2)

In the event of a failure of the sample to satisfy a test, the retesting procedure shall be as follows :

- If only one insulator or metal part fails to comply with the sampling tests, a new sample equal to twice the quantity originally submitted to the tests shall be subjected to retesting. The retesting shall comprise the test in which failure occurs.
- If two or more insulator or metal parts fail to comply with any of the sampling tests or if any failure occurs during the retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.
- Provided the cause of the failure can be clearly identified, the manufacturer may sort the lot to eliminate all the insulators with these defects. The sorted lot then be resubmitted for testing. The number then selected shall be three times the first chosen quantity for tests. If any insulators fail during this retesting, the complete lot is considered as not complying with this standard and shall be withdrawn by the manufacturer.

12.2 Verification of dimensions (E1 + E2)

The dimensions given in the drawings shall be verified. The tolerances given in the drawing are valid. If no tolerances are given in the drawings the values mentioned in this specification shall hold good.

12.3 Verification of the locking system (E2)

This test applies only to the insulators equipped with socket coupling as specified by IEC 120 and is performed according to IEC 383.

12.4 Verification of tightness of the interface between end fittings & Insulator housing (E2)

One insulator selected randomly from the sample E2, shall be subjected to crack indication by dye penetration, in accordance with ISO 3452,on the housing in the zone embracing the complete length of the interface between the housing and metal fitting and including an additional area, sufficiently extended beyond the end of the metal part. The indication shall be performed in the following way.

- the surface shall be properly pre-cleaned with the cleaner ;
- the penetrant, which shall act during 20 minutes, shall be applied on the cleaned surface;
- within 5 minutes after the application of the penetrant, the insulator shall be subjected, at the ambient temperature, to a tensile load of 70 % of the SML, applied between the metal fittings; the tensile load shall be increased rapidly but smoothly from zero up to 70 % of the SML, and then maintained at this value for 1 minute;

- the surface shall be cleaned with the excess penetrant removed, and dried;
- the developer shall be applied if necessary;
- the surface shall be inspected.

Some housing materials may be penetrated by the penetrant. In such cases evidence shall be provided to validate the interpretation of the results.After the 1 min. test at 70 % of the SML, if any cracks occur, the housing and, if necessary, the metal fittings and the core shall be cut, perpendicularly to the crack in the middle of the widest of the indicated cracks, into two halves. The surface of the two halves shall then be investigated for the depth of the cracks.

12.5 Verification of the specified mechanical load SML

The insulators of the sample E1 shall be subjected at ambient temperature to a tensile load, applied between the couplings. The tensile load shall be increased rapidly but smoothly from zero to approximately 75 % of the SML, and then be gradually increased to the SML in a time between 30 sec. to 90 sec. If 100 % of the SML is reached in less than 90 s, the load (100 % of the SML) shall be maintained for the remainder of the 90 s. (This test is considered to be equivalent to a 1 min withstand test at the SML). The insulators have passed the test at 13.4 & 13.5 above if:

- No failure (breakage or complete pull out of the core, or fracture of the metal fitting) occurs either during the 1 min. 70 % withstand test (a) or during the 1 min.100 % withstand test (b).
- No cracks are indicated after the dye penetration method described in 13.4 above.
- The investigation of the halves described in 13.4 above shows clearly that the cracks do not reach the core.

12.6 Galvanizing test

This test shall be performed according to IS: 2633/IS: 6745 on galvanized parts.

13.0 MARKINGS:

Each insulator shall be legibly and indelibly marked with the following details as per IEC- 61109:

a) Name or trademark of the manufacturer.
b) Voltage & Type
c) Month and year of manufacturing.
d) Min. failing load/guaranteed mechanical strength in kilo Newton followed by the word 'KN' to facilitate easy identification.
e) Country of Manufacturer.

14.0 PACKING :

14.1 All insulators shall be packed in strong corrugated box of min. 7 ply duly paletted or wooden crates. The gross weight of the crates along with the material shall not normally exceed 100 Kg to avoid hackling problem. The crates shall be suitable for outdoor storage under wet climate during rainy season.

14.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

14.3 Suitable cushioning, protective padding, or Dunn age or spacers shall be provided to prevent damage or deformation during transit and handling.

14.4 All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case /crate /corrugated box shall have all the markings stenciled on it in indelible ink.

14.5 The bidder shall provide instructions regarding handling and storage precautions to be taken at site.

Annexure-A

STANDARDS TO BE ADOPTED FOR COMPLETE INSULATORS

Sl No	IS Standard	Title	International Standard
1		Definition. test methods and acceptance criteria for composite insulators for a.c. overhead lines above 1000 V	IEC: 61109
2	IS: 731	Porcelain insulators for overhead Power lines with a nominal voltage greater than 1000 V	IEC: 60383
3	IS: 2071	Methods of High Voltage Testing	IEC: 60060-1
4	IS: 2486	Specification for Insulator fittings for Overhead Power Lines with a nominal Voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	IEC: 60120 IEC: 60372
5		Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
6	IS: 13134	Guide for the selection *of* insulators in respect *of* polluted Conditions	IEC: 60815
7		Characteristics *of* string insulator units *of* the long rod type	IEC: 60433
8		Hydrophobicity Classification Guide	STRI Guide 1.92/1
9		Radio interference characteristics *of* overhead power lines and high-voltage equipment.	CISPR:18-2 Part-2
10	IS: 8263	Methods *of* RI *Test of* HV insulators	IEC: 60437
11		Standard for Insulators Composite-Distribution Dead-end Type	ANSI C29. 13-2000
12	IS: 4759	Hot dip zinc coatings on structural steel & other allied products	ISO:1459 ISO:1461
13	IS:2629	Recommended Practice for Hot. Dip . Galvanisation *for* iron and steel	ISO:1461(E)
14	IS: 6745	Determination *of* Weight *of* Zinc Coating on Zinc coated iron and steel articles	ISO:1460
15	IS:3203	Methods *of* testing of local thickness *of* electroplated coatings	ISO:2173
16	IS:2633	Testing *of* Uniformity *of* Coating *of* zinc coated articles	
17		Standard specification *for* glass fiber strands	ASTM D 578-05
18		Standard test method *for* compositional analysis by Thermogravimetry	ASTM E 1131-03
19	IS: 4699	Specification for refined secondary Zinc	

Annexure-B

Tests on Insulator units

1. RIV Test (Dry)

The insulator string along with complete hardware fittings shall have a radio interference voltage level below 100 micro volts at one MHz when subjected to 50 Hz AC voltage of 10 kV & 30 kV for 11 kV insulators under dry condition. The test procedure shall be in accordance with 15:8263 IEC: 437/CISPR 18-2.

2. Brittle Fracture Resistance Test

Brittle fracture test shall be carried out on naked rod along with end fittings by applying "1 n HN03 acid" (63 gm conc. HN03 added to 937 gm water) to the rod. The rod should be held at 80% of SML for the duration of the test. The rod should not fail within the 96-hour test duration. Test arrangement should ensure continuous wetting of the rod with Nitric acid.

3. Recovery of Hydrophobicity & Corona test

The test shall be carried out on 4mm thick samples of 5cm x 7cm.

i) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the Hydrophobicity classification in line with STRJ guide for Hydrophobicity classification (Extract enclosed at Annexure - D). Dry the sample surface.

ii) The sample shall subjected to mechanical stress by bending the sample over a ground electrode. Corona is continuously generated by applying 12 kV to a needle like electrode placed 1 mm above the sample surface. The test shall be done for 100 hrs.

iii) Immediately after the corona treatment, spray the surface with water and record the HC classification. Dry the surface and repeat the corona treatment as at clause 2 above. Note HC classification. Repeat the cycle for 1000 hrs. or until an HC of 6 or 7 is obtained. Dry the sample surface.

iv) Allow the sample to recover and repeat hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 - HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

4. Chemical composition test for Silicon content

The content of silicon in the composite polymer shall be evaluated by EDX (Energy Dispersion X-ray) Analysis or Thermo-gravimetric analysis. The test may be carried out at CPRI/ERDA or any other NABL accredited govt laboratory.

SPECIFICATION FOR G.I. WIRES.

1.0 FOREWORD

G.I. Wires of different sizes are used in distribution system for various applications such as earthing of metallic fittings, bearer wire for service cables, guarding of power lines etc.,

2.0 SCOPE

This specification covers details of solid G.I. Wires for use in distribution system.

3.0 APPLICABLE STANDARDS

Except when they conflict with the specific requirements of this specification, the G.I. Wires shall comply with the provisions of IS:280-1978 and IS:7887-1992 or the latest version thereof.

4.0 APPLICATION & SIZES

G.I. Wires covered in this specification are intended for the following applications.

Applications		Size (nominal dia)
i) Bearer wire for service cables	-	3.15mm (for single phase services)
ii) Earthing of transformers, poles	-	4mm (for three phase service lines)
iii) Continuous earth wire for 11KV	-	4mm.
iv) Protective guarding at the crossing of overhead power lines with roads, railway tracks and tele-communication lines.	-	3.15, 4 & 5 mm

5.0 MATERIAL

5.1 The wires shall be drawn from the wire rods conforming to IS:7887-1992 or the latest version thereof.

5.2 The requirements for chemical composition for the wires shall conform to IS:7887.

5.3 The wire shall be sound, free from split surface flaws, rough jagged and imperfect edges and other detrimental defects on the surface of the wires.

5.4 The wires shall be galvanized with Heavy Coating as per IS: 4826-1979 (275g/m²) or the latest version thereof.

6.0 GRADES

G.I. Wires shall be of Annealed Grade with Tensile Strength of 300-550 MPA.

NOTES : 1) 1 MPa = lN/mm2 = I MN/m2 = 0.1020 kgf/mm2.

2) Restricted ranges of tensile strength in case of galvanized wire may be Agreed to at the time of enquiry and order.

7.0 TOLERANCE ON DIAMETER

The tolerance on nominal diameter at any section of wire shall not exceed ±2.5%. Further, the maximum difference between the diameters at any two cross-sections of wires shall not exceed 2.5%.

8.0 TESTS

The following tests shall be carried out in accordance with IS:280 -1978 or the latest version thereof as per sampling criteria stipulated therein.

i. Dimensional check (dia)
ii. Visual inspection regarding freedom from defects
iii. Tensile test.
iv. Wrapping test (for wire diameters smaller than 5mm)
v. Bend test (for wire diameter 5mm only)
vi. Coating test
vii. Chemical composition

9.0 PACKING

9.1 The wires shall be supplied in 50-70 kg coils each having single continuous length. Each coil of wire shall be suitably bound and fastened compactly and shall be protected by suitable wrapping.

9.2 Each coil shall be provided with a label fixed firmly on inner part of the coil bearing the following information:

a) Manufacturer's name or trade mark
b) Lot number and coil number
c) Size
d) Grade
e) Mass
f) Length
g) ISI Certification mark, if any.

---------- X ----------

BANGALORE ELECTRICITY SUPPLY COMPANY

TECHNICAL SPECIFICATION FOR STAY STRANDED G.I. WIRE (Guy Wire)

1.0 SCOPE:

This specification provides for manufacture, testing before dispatch, supply and delivery of Galvanised Stranded Steel Wire.

2.0 STANDARDS:

The G.I. Stranded wire shall comply with the following India Standards with their latest amendments if any.

a) I.S.-2141/1979 and the relevant standards indicated there.

b) Hot dip galvanized coatings for stranded wire shall conform to IS-4826/1979 and revisions thereof.

PART-'A'-STRANDED WIRE

3.0 MATERIAL:

3.1 The wire shall be drawn from steel made by the open-hearth basic oxygen or electric furnace process and of such quality that when drawn to the size of wire specified and coated with zinc, the finished strand and the individual wires shall be of uniform quality and have the appropriate properties and characteristics as specified in this specification. The wires shall not contain sulphur and phosphorus exceeding 0.060% each.

3.2 The wire shall be coated with zinc of grade – Zn-89-S:209/1966.

3.3 The wires shall be circular and shall be free from scale, irregularities, imperfections, split surface flaws, rough, jagged and imperfect edges. The zinc coating shall be smooth, even and bright.

3.4 Joints shall be permitted in the individual wires during stranding, but these stranding joints shall not be less than 15 Mrs. Apart in the finished strands.

4.0 **CONSTRUCTION**:

4.1 The wires shall be of grade-4 having minimum tensile strength of 70 kg. per sq.mm.

4.2 The constructional details shall be as specified in Table-'A' below. The galvanized stay strand shall be of 7 (seven) wires and the wire shall be so stranded together that when an evenly distributed pull is applied at the ends of the completed wire, each strand will take an equal share of the pull.

TABLE – 'A': SINGLE WIRE

No. of Wires	Dia Min.	Tolerance %	Min. elonga-tion (%)	Min breaking load before Stranding for single wire (KN)	Length of Lay	Min. breaking load of strand (KN)
7	3.15	±2.5% with a minimum of 0.025 mm.	10	5.45	12 to 18 times the strand diameter	36.26

5.0 **SAMPLING CRITERIA**:

Sampling criteria and the tests shall be in accordance with IS-2141-1979.

6.0 **TESTS**:

6.1 **TESTS ON WIRES BEFORE MANUFACTURE**:

1) Ductility test in accordance with IS-1755.
2) Measurement of diameter.

6.2 **ACCEPTANCE TESTS ON COMPLETE STRAND:**

i) Tensile and elongation tests as per IS-2141.

ii) Chemical analysis of sample from each lot.

iii) Coating test.

The uniformity of zinc coating shall be tested by the method specified in IS-2633/1964. The wire shall withstand the No. of dips as specified in IS-4826-1979 as indicated below in Table-'B':

TABLE-'B': WEIGHT OF COATING AND NUMBER OF DIPS-HEAVILY COATED WIRE:

Nominal diameter of galvanized wire in mm	HARD		
	Weight of coating gms/Sq.mtr.	No. of dips	
		1 Min.	½ Min.
3.15	250	3	-

Hard galvanized after drawing without annealing.

PART-'B'-GENERAL

7.0 **WEIGHT OF COIL:**

The stranded wires shall be supplied around 50 Kg. coils.

8.0 **MARKING:**

Each coil shall be provided with a metallic label fixed firmly on the inner part of the coil beating the following information:

i) Manufacturer's name or Trade mark,

ii) Number and Coil No.

iii) Size Length Mass

iv) ISI-Certification mark, if any,

v) Identification Mark-BESCOM P.O. No.

The above shall be legibly stamped upon a metallic tape securely attached to the coil.

8.1 **PACKING:**

Each coil shall be wrapped in hessian and packed in a manner acceptable to the Purchaser. The packing should have the mark BESCOM and Purchase order No.

8.2 **GUARANTEED TECHNICAL PARTICULARS:**

The tenderers shall furnish the Guaranteed Technical Particulars as per enclosed format.

9.0 **INSPECTION:**

The Supplier shall afford necessary facilities to the representative of the Board to inspect his works during the process of manufactured of the material. All tests as per relevant ISS are to be conducted in the presence of Board's representative. The Supplier must intimate the programme of test atleast 15 days in advance to enable the Board to depute their representative for witnessing the tests. Type tests shall also be conducted on selected samples if found necessary, before the Board's representative.

Guaranteed Technical Particulars for G.I. Wire Stranded Wire-7/3.15mm (Guy Wire)

STRANDED WIRE:

1	Maker's Name & Address	:	
2	Single wire before stranding		
	a) Diameter in mm.	:	
	b) Tolerance in diameter in mm.	:	
	c) Minimum elongation in 100 mm ..... in mm	:	
	d) Minimum breaking load in Kgf.	:	
3	Stay-Starnded Wire	:	
	a) Length of lay in mm.	:	
	Minimum	:	
	Maximum	:	
	b) Minimum breaking load in Kgf.	:	
4	Tensile strength of wire in Kgf./mm²	:	
5	Overall dia. Of stranded wire	:	
6	Sectional area of stranded wire in mm²	:	
7	Electrical resistance in ohms. Per KM at 20 Deg. C	:	
8	Coating test:	:	
	a) Type of Zinc coating, whether heavy or Light	:	
	b) Weight of coating in gms./ mm²	:	
	c) No. of dips 1 min.	:	
	½ min.	:	
9	Tensile test	:	
	Minimum tensile strength of 100 mm. gauge length of wire	:	
10	Ductility Test	:	
	Condition of wire when wrapped 8 times round its own dia and on being sub-sequently straightened	:	

11	a) Length of wire in each coil in meters	:	
	b) Tolerance (%)	:	
12	a) Weight of each coil	:	
	b) Tolerance (%)	:	
	c) Weight of wire in Kg./Km.	:	
	Standard according to which staystrand is manufactured and tested	:	
13	Details of packing	:	

Firm seal & Signature

SPECIFICATION FOR HORIZONTAL CROSS ARMS

1.0 SCOPE

This specification provides for the manufacture of Horizontal straight cross arms for use in 11KV distribution lines.

2.0 STANDARDS

The structure steel for the manufacture of cross arm shall be commercial grade angles 50 x 50 x 6 mm and conform to I.S.1977/ST-42/ST-32. They should take particular care to ensure the hardness of the steel used is as per the said ISS.

3.0 DRAWINGS

The material for 11KV horizontal cross should conform to our Drg. No. BESCOM/GM/QS&S/4. Dated 24.11.208.

4.0 PAINTING

The clamps shall be painted with two coats of good quality Anti Corrosive Black (ACB) paint after 2 coats of red oxide primer.

5.0 MARKING

The cross arm should have voltage grade (11KV) marked on it.

6.0 SAMPLE

The Contractor shall submit a sample and get the approval of the Engineer before taking up the works.

7.0 PACKNG

The cross arms shall be securely packed to avoid damages during transport.

8.0 LENGTH AND WEIGHT

Each horizontal cross arm shall be 980 mm length and weight 4.86 Kg/ piece, as mentioned in the drawings.

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TECHNICAL SPECIFICATION FOR
1.1kV GRADE ARMOURED COPPER CONTROL CABLES:

1.0 **SCOPE:**

1.1 The specification covers engineering, manufacture and testing at Manufacturers works and supply of ordered quantity of 1.1kV grade FR-LSH armoured copper control cables.

1.2 It is not the intent to specify the design details completely. However the supplier shall manufacture the Control Cables confirm to high standard of engineering and workmanship and shall be capable of performing satisfactorily in field.

1.3 Preferred sizes of the control cables required are listed below:

a. 2C x 4 sq mm
b. 4C x 4 sq mm
c. 4C x 6 sq mm
d. 2C x 2.5 sq mm
e. 4C x 2.5 sq mm
f. 7C x 2.5 sq mm
g. 10C x 2.5 sq mm
h. 14C x 2.5 sq mm
i. 24C x 2.5 sqmm
j. 24C x 0.75 sqmm.

2.0 **STANDARDS:**

2.1 Materials used for the manufacture of 1.1kV grade copper Control Cables shall confirm in all respects to latest relevant standards and its amendments.

Sl. No.	Standards	Title - Specification for
1	IS : 1554	PVC insulated (heavy duty) electric cables for working voltage up to and including 1 100 V
2	IS : 8130	Conductors for insulated electrical cables and flexible cords.
3	IS : 5831	PVC insulation and sheath of electrical cables
4	IS : 3975	Mild steel wires strips and tapes for armoring of cables
5	IS : 3961	Recommended current ratings for cables
6	IS : 10418	Specification of drums for electric cables
7	ASTMD	Measuring and minimum oxygen concentration to support 2683 candle like combustion of plastic (oxygen index)

8	IEC 61034-1: 2005	Measurement of smoke density of cables burning under defined conditions

2.2 Cables complying with other internationally accepted standards such as IEC, VDE, JPCEA etc., will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard/standards adopted and furnish a copy of English version of the latest revision of the standard(s) along with the tender and shall clearly bring out the salient features for comparisons.

2.3 1.1kV grade control cables to be supplied under this package shall be ISI approved and marked as such. Non-compliance of above shall not be accepted.

3.0 SYSTEM DETAILS:

3.1 The Control Cables shall be suitable for use on AC single phase 250V supply or AC 3-phase 433V supply (earthed or unearthed) systems. The cables shall also be suitable for use in 110V/220V DC supply system.

3.2 The control cables shall be suitable for continuous operating condition even at 110% of rated voltage.

3.3 The control cables shall be suitable for operations, where the combination of ambient temperature and temperature rise due to load during usage of cable for general purpose is 70^{0}C for normal continuous operations.

4.0 SERVICE CONDITIONS:

4.1 The Control cables supplied shall be suitable for satisfactory continuous operation.

5.0 DESIGN AND CONSTRUCTION:

5.1 Conductor:

5.1.1 The copper wires used for manufacturing the cables shall be true circular in shape before stranding and should be uniformly of good quality copper free from defects and shall conform in all respects of IS:8130.

5.2 Insulation:

5.2.1 All types of insulating materials used for control cables shall be conforming to the requirements of IS:5831-1984.

5.2.2 The insulation shall be type A PVC compound and the conductor shall be covered with PVC insulation applied by extrusion. It shall be ensured that the shape is as circular as possible.

5.2.3 The insulation on the conductor shall be so applied that it fits closely on the conductor and it shall be possible to remove it without damage to the conductor.

5.2.4 Filler and inner sheath shall be of non-hygroscopic and shall not be harder than PVC used for conductor.

5.2.5 The fire retardant low smoke outer sheath shall be of type ST-1 PVC compound and shall be grey in colour.

5.3 **Armour**:

5.3.1 Armouring shall be applied over the inner sheath.

5.3.2 Only galvanized round steel wire armour shall be used for multicore cables. G.S. strip armour shall not be accepted for these cables.

5.3.3 The armour wires shall be applied as closely as practicable.

5.3.4 The joints in armour wires shall be made by brazing or welding and the surface irregularities shall be removed.

5.3.5 A joint in any wire shall be at least 300mm from the nearest joint in any other wire in the completed cable.

6.0 **TECHNICAL REQUIREMENTS**:

6.1 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chance of flooding by water.

6.2 They shall be designed to withstand all mechanical, electrical and thermal stress under steady and transient operating conditions.

6.3 Progressive sequential marking of the length of the cable in meters shall be provided for every one meter on the outer sheath of all cables.

6.4 All cables shall pass fire resistance test as per IS:1554 (part-1) and Smoke density (Emission of smoke) test as per IEC 61034-1:2005 conducted on cable.

6.5 The normal current rating of cables shall be as per IS:3961.

6.6 The cables shall have outer sheath of material with an oxygen index of not less than 29% and Temperature index of not less than 250 deg C.

6.7 Repaired cables will not be accepted.

6.8 Allowable tolerances on the overall diameter of the cables shall be plus or minus 2mm.

6.9 Cores shall be identified as per IS:1554 for the cables up to five cores.

6.10 For cables with more than 5 cores, the insulation of the cores shall be of same colour and numbered sequentially, starting with 1 for the inner core for identification of each core. Numbering shall be done by printing legible Hindu Arabic numerals on all the cores. The numbers shall be repeated at regular intervals along the core.

6.11 Standard lengths for each size of control cables to be supplied shall be 500/1000 meters.

7.0 CORE DRUMS:

7.1 Cables shall be supplied in non-returnable wooden drums of heavy construction and drum shall be properly seasoned sound and free from defects.

7.2 Wood preservative shall be applied to the entire drum.

7.3 The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard length.

7.4 The owner shall have the option of rejecting cable drums with shorter lengths. However, the total quantity of cables after taking into consideration of all cable drum of each size shall be within tolerance of 2%.

7.5 A layer of waterproof paper shall be applied to the surface of the drums over the outer most cable layer.

7.6 A clear space of atleast 40mm shall be left between the cables and lagging.

7.7 Each drum shall carry the manufacture's name, the owner's name, address, contract number & type, size & length of the cable, net & gross weight stenciled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

7.8 Packing shall be sturdy & adequate to protect the cables from any injury due to mishandling or other conditions encountered during handling, transportation and storage. Both cables ends shall be sealed with good quality heat shrinkable caps so as to eliminate ingress of water during transportation & erection.

8 TESTS:

8.1 Type Tests:

8.1.1 Type tests on cables shall be conducted on each type and size of cables offered.

8.1.2 The following shall constitute the type tests:

A. As per IS-1554 (Part I) with latest amendments.

a) Tests on conductor:
   1) Annealing test
   2) Resistance test
b) Tests for armouring wires.
c) Tests for thickness of insulation and sheath.
d) Physical tests on insulation and outer sheath
   1) Tensile strength and elongation at break
   2) Ageing in air oven
   3) Shrinkage test
   4) Hot deformation test
   5) Loss of mass in air oven.
   6) Heat shock test.
   7) Thermal stability
e) Insulation resistance test.
f) High voltage test at room temperature.
g) High voltage test (water immersion test)
h) Flammability test
i) Oxygen index test
j) Flame retardance test
k) Test for halogen acid gas evolution
l) Temperature index test

B. As per IEC-61034 with latest amendments.

a) Smoke density test (Emission of Smoke): This specifies a test for determination of smoke density. The "3 metre cube test" measures

the generation of smoke from electric cables during fire. The minimum light transmission is recorded. The result is expressed as percentage of light transmitted. The specimen is deemed to pass this test (IEC 61034-1&2) if the value is greater than 60%. The higher the light transmittance, the less smoke emitted during a fire.

8.2 Routine Tests:

8.2.1 Tests made by the manufacturer on all finished cable length to demonstrate the integrity of cables and all tests as per IS:1554(part-1) constitutes routine tests and the test reports are to be furnished while offering the manufactured control cables for witnessing the acceptance tests.

8.3 Acceptance Tests:

8.3.1 Following are the acceptance tests to be conducted on the samples taken from a lot for the purpose of acceptance of that lot in presence of BESCOM inspecting officers.

a) Annealing test
b) Conductor resistance test
c) Test for thickness of insulation and sheath.
d) Tensile strength and elongation at break of insulation and sheath.
e) Insulation resistance test.
f) High voltage test at room temperature.

Note: Since the Di-electric tests are conducted as routine tests also during acceptance test to be conducted at the reduced voltage level of 75% of the original values.

9.0 QUALITY ASSURANCE PLAN:

9.1 The bidder shall furnish the detailed quality assurance programme for the raw materials as well as quality control during manufacturing.

9.2 The successful bidder shall submit and seek approval for the QAP.

9.3 The bidder shall submit the list of testing equipment available for conducting required tests as per standards.

9.4 The supplier shall, within 30 days of placement of order, submit following information.

a) List of raw materials as well brought out accessories and the names of sub suppliers selected from those furnished along with offer.

b) Type test certificates of the raw material and bought out accessories.

10.0 GUARANTEE:

10.1 The manufacturers of the control cables shall provide a guarantee.

11.0 INSPECTION:

11.1 The supplier shall give 10 days advance intimation to the purchaser to organize for inspection and all the acceptance tests shall be conducted in presence of BESCOM inspecting officers.

11.2 The firm shall produce routine test certificate at the time of conducting acceptance test.

12.0 DOCUMENTATION:

12.1 All drawings shall conform to relevant standards.

12.2 The suppliers should manufacture and supply the control cables as per the specifications and no deviations are permitted.

12.3 Type test certificates for having conducted test at M/s CPRI/ERDA or any Government laboratory shall be submitted along with the tender.

12.4 Approval of drawings / work by BESCOM shall not relieve the supplier of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirement of the latest revision of applicable standards, rules and codes of practices. The control cables shall conform in all respects to high standards of engineering design workmanship and latest revisions of relevant standards at the time of supply and the BESCOM shall have the power to reject any work or materials which in his judgment is not in full accordance there with.

13.0 PACKING AND FORWARDING:

13.1 Each consignment shall be accompanied by a detailed packing list containing the following information.

a) Name of the Consignee.
b) Details of Consignment.
c) Destination.
d) Total weight of consignment.